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ARMY AVIATION RDT AND E PLAN. EXECUTIVE SUMMARY.(U)

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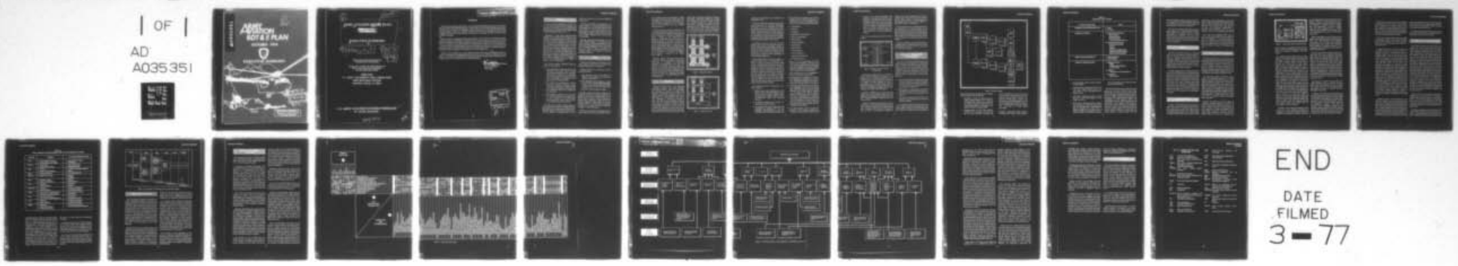

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ARMY AVIATION RDT & E PLAN

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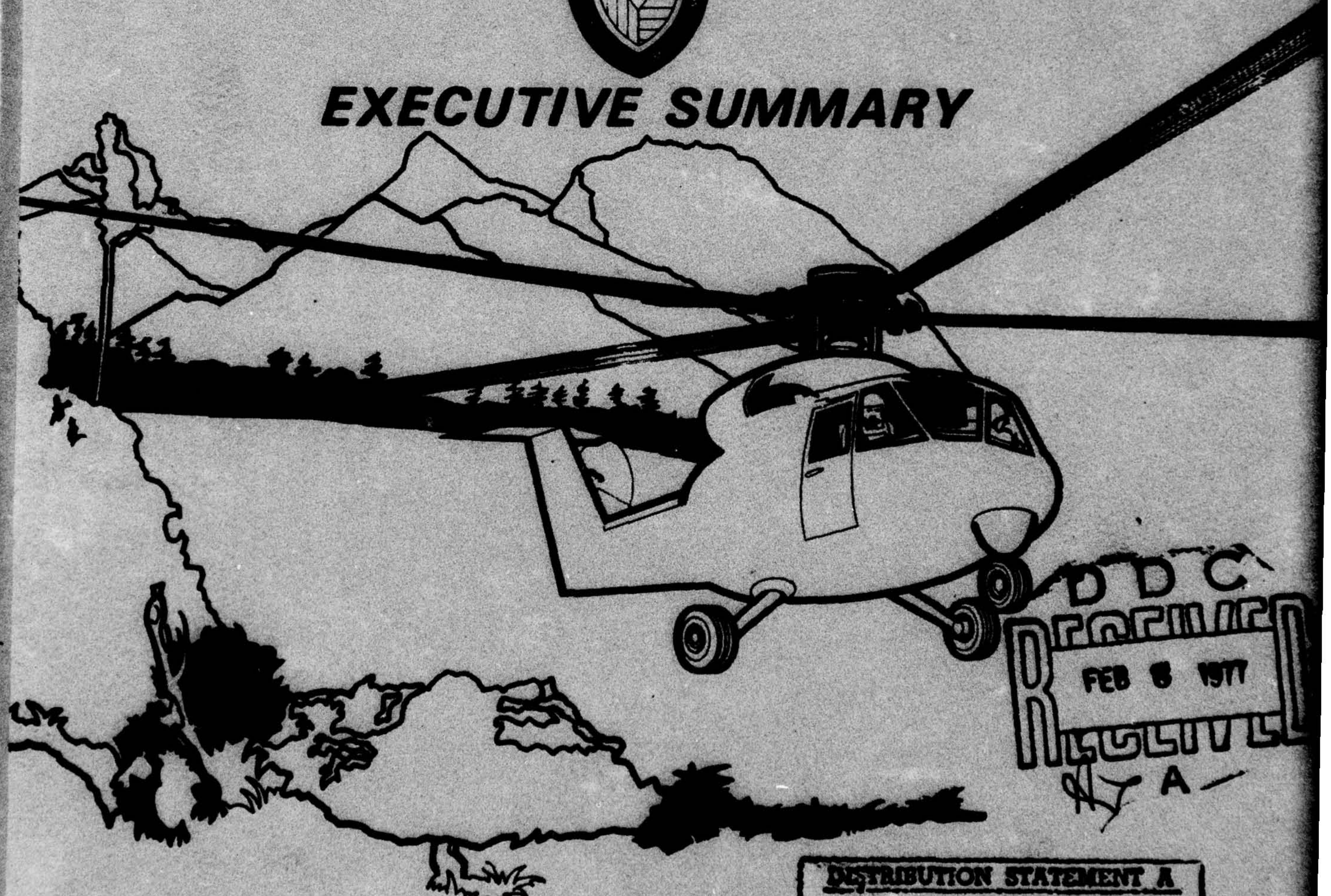
EXECUTIVE SUMMARY



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EXECUTIVE SUMMARY.

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U.S. ARMY AVIATION SYSTEMS COMMAND
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FOREWORD

The Army Aviation Research, Development, Test and Engineering (RDT&E) Plan is the U.S. Army Aviation Systems Command (USAAVSCOM) response to the requirement for a Consolidated R&D Plan, which constitutes Block 13a in the Life-Cycle Management Model as described in the Joint CDC/AMC Materiel Need Procedures Handbook, March 1972. This Plan is prepared and maintained by AVSCOM on a continuing basis to address the short- and long-range RDT&E activities directed to achieving the Army objectives for which AVSCOM is responsible.

The Plan presents a time-phased analysis and presentation of the scientific and technological programs required to support the development of advanced airmobile systems responsive to the future needs of the Army. This document sets forth plans and objectives for Army aviation research and development activities for the FY77–96 periods, with particular emphasis on the period from the present to 1981. Current R&D efforts in Army air mobility are directed primarily toward the development of a family of vertical and short takeoff and landing aircraft to fulfill identified requirements in the land combat functions of mobility, intelligence, firepower, combat service support, and command, control, and communications.

The Plan, with its classified annex, is quite voluminous because of the broad scope of activities and the wide variety of technologies and disciplines that constitute the totality of the air vehicle technology. This Executive Summary of the Army Aviation RDT&E Plan is intended to provide a practical, concise overview of the Plan making it a useful tool for the higher echelons of R&D management.

EIVIND H. JOHANSEN
Major General, USA
Commanding

PURPOSE

The Army Aviation RDT&E Plan is prepared by the U.S. Army Aviation Systems Command as its response to the requirement for a Consolidated R&D Plan described in the Joint CDC/AMC Materiel Need Procedures Handbook, March 1972.

Superiority of future Army airmobile systems depends on the availability and exploitation of new scientific knowledge, the existence of which can only be estimated. The development of a firm technology base to meet projected requirements can be assured by formulating a time-phased prediction of technical potential set forth in an orderly sequence of coordinated activities in the many disciplines and technologies required to develop airmobile systems. An objective of the Army Aviation RDT&E Plan is to provide such an evaluation of technical potential. The Plan presents an instantaneous assessment, and therefore requires continual review and updating to account for technological advances or changes in threat or policy for requirements.

The primary concepts emphasized during the preparation of this Plan are:

- The establishment of substantial research and exploratory development efforts directed toward the long term satisfaction of technological deficiencies; vitalization of the technology base; pursuit of aggressive policies, with innovation as appropriate, for stimulation of the productivity of the technology base.
- The initiation and continuation of specific prototypes, advanced technology demonstrators and new initiatives to exploit promising new concepts and technology potentially capable of substantial impact in areas of significant force deficiency.
- The continued development, test, and evaluation of major systems with a substantial effort to orient programs for their development toward achievement of more realistic production, operational, and maintenance costs.

The Plan seeks to explore all viable options for future systems, with the goal of providing knowledgeable elimination of options and identification of optimum concepts for development when required. The more distant the operational date, the more options are pursued, and at the more fundamental research level.

The Plan is intended as a management tool to provide visibility of acknowledged requirements and interdependence of necessary technological achievements. While the Plan establishes the basis for programming, it is not in itself a program. It is not constrained by available resources, but is the foundation on which a program can be structured within such constraints.

The Plan is dedicated to development of the best combat vehicles possible for the defense of this country. However, the planned developmental activities are continually cognizant of the need to minimize any environmental degradation that might occur because of operation of these new systems. Great emphasis is placed on the reduction of noise and atmospheric pollution.

SCOPE

The Plan sets forth plans and objectives for Army aviation R&D activities for FY77 through 96, with particular emphasis on FY77 through 81.

The Plan addresses, and is in harmony, with the following documents:

- DA objectives, policies, and guidance for RDT&E including Science and Technology Objectives Guide (STOG–77).
- HQ, DARCOM objectives, policies, and guidance provided by the annual Planning Guidance document, the Integrated R&D Plan, RDTE program guidance, and Five Year Defense Plan.
- TRADOC Combat Development Studies.

The Plan considers and is closely coordinated with R&D programs of other U.S. Army organizations. In particular, activities are coordinated in the areas of Human Factors, Avionics, Ground Handling, and Weapons where performance requirements necessitates the integration of these factors into the total airmobile system, but where mission responsibility for R&D is in or shared with another commodity command or corporate laboratory.

The Plan is in consonance with foreign R&D and related activities, both from the standpoint of threat

from a potential enemy and exploitation of Allied developmental efforts. The latter is achieved by active participation and communication with NATO countries through the Advisory Group for Aerospace Research and Development and The Technical Cooperation Panel.

The Plan describes research, development, test, and engineering activities appropriate to Army aviation from fundamental research through operational system development. A description of RDT&E programs is included in Army Regulation 705–5. Because of the dependence of new structural and propulsion concepts on concurrent development of advanced manufacturing methods for proof of viability and economical fabrication of components, programs normally falling under the category of Manufacturing Methods and Technology (MMT) Engineering Measures are included in this Plan. MMT as a part of Procurement of Equipment and Missiles, Army (PEMA) is described in Army Regulation 37–100–72.

This Plan includes a Resources Required (RR) section that describes the funding and manpower requirements to accomplish the technological improvement goals identified in the Plan. Also included in the AMRDL technology sections is a subsection on Laboratory Project Selection Process. This process provides Laboratory management with a systematic project selection procedure. The process is described in detail in the Technology Introduction section and is referred to as OPR–Objectives, Priorities and Rationale.

APPROACH

Planning is defined as selecting the appropriate organizational objectives and policies, determining the technical potential to satisfy them, and establishing procedures and methods for achieving those objectives. Technological forecasting, which is an implicit element of the planning process, can be approached by two different methods: (1) "exploratory" forecasting of technology, conjectural in nature, that seeks to project technology parameters from a base of accumulated knowledge in relevant areas (see figure 1); and (2) "normative" forecasting of technology, deterministic in nature, that is constrained by the objectives of future requirements (see figure 2). Generally, the latter approach is followed in the preparation of this Plan. In this process, future systems goals are identified and assessed to determine technological requirements (voids). By analyzing these requirements regressively through the R&D cycle, specific discipline and functional research requirements are identified, which then become the elements from which R&D programs can be developed. This process has been typed "demand pull," since technological advance is generally accelerated by responding to specific needs. The two types of

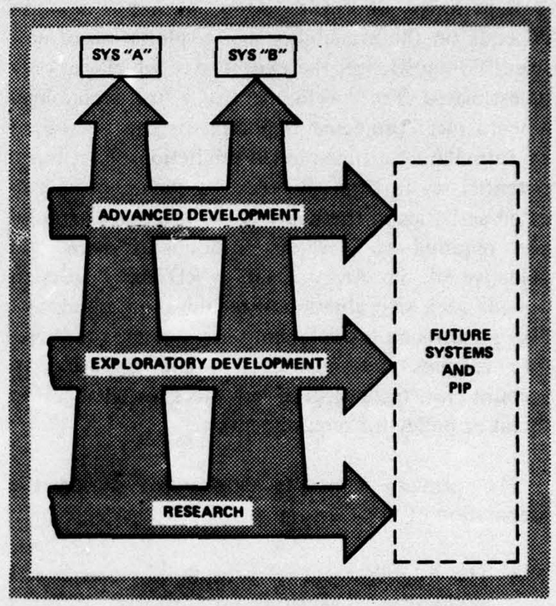

Figure 1. Exploratory forecast.

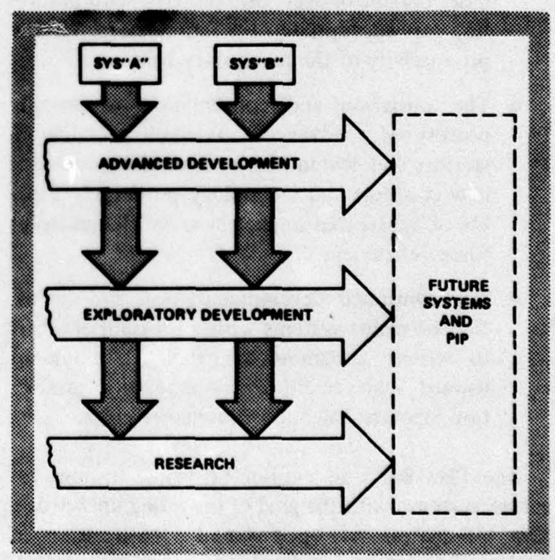

Figure 2. Normative forecast.

forecasting are complementary, not competitive, and both should be used.

Research and development planning cannot ignore future opportunities for producing technological advancements. It is worth noting that future threats and military operations are more affected by technological events than by the methods and tactics of previous situations. Therefore, the Plan reflects not only the response to the currently projected capability requirements, but also the need for a technological base that will stimulate innovative and imaginative airmobile missions, functions, and concepts.

Considerable uncertainty occurs in long range planning where some of the alternatives cannot be forecast. Technological breakthroughs, variations in threat projections, and fiscal constraints are areas of greatest uncertainty. Within the limitations of such uncertainties, this Plan provides for integrating the requirements for research to fill technical gaps and avoid nonessential duplication.

Current R&D efforts in Army air mobility are directed primarily toward the development of a family of vertical and short takeoff and landing aircraft to fulfill identified mission requirements for the five basic land combat functions of mobility, intelligence, firepower, combat service support, and command, control, and communication. Efforts are conducted in physical, mathematical, environmental and life sciences, and in low-speed aeronautics, air-breathing propulsion, aircraft armament, vulnerability, survivability, crew protection, and support equipment. These efforts extend also into the fundamental research areas to generate increased knowledge for future air mobility concepts.

The approach taken for the preparation of the Plan is as follows:

- Desired Army aviation capabilities are identified in the form of projected missions/functions without regard to specific candidate systems and with particular emphasis placed on current DA/DARCOM science and technology objectives.
- All apparent possible ways to perform each mission/function are determined.
- An anticipated IOC date is projected for each mission/function identified above. The most promising concepts/systems to meet the requirements then are identified and discussed.
- The performance requirements and technical problem areas of each concept/system are interpreted in terms of technological requirements in 13 basic and supporting technologies:
  - Aerodynamics
  - Structures
  - Propulsion
  - Reliability and Maintainability
  - Safety and Survivability
  - Mission Support
  - Aircraft Subsystems
  - Weaponization
  - Human Factors
  - RPV Technology
  - Aviation Electronics
  - Manufacturing Technology
  - Mathematical Science
- Each of these 13 technologies are further divided into subdisciplines within which all work objectives can be categorized. The desired performance capabilities of the most probable systems are translated into quantitative technological requirements for each subdiscipline.
- The state-of-the-art of each subdiscipline is defined quantitatively, where possible.
- Technology gaps are identified (i.e., the necessary quantitative improvements for each of these subdisciplines are defined with respect to the performance requirements for each system).
- Technology planning objectives are defined in each subdiscipline based on the technology gaps, technology forecast, and expert opinion regarding future potential based on extrapolation of existing trends. Wherever possible, quantitative improvement goals are defined in the form of key-parameter or quality-trend curves and the quantified objectives are related to the requirements of the future missions. In each area, consideration is given to the important causal factors and relationships with other disciplines and technologies.
- An orderly sequence of events by which the objectives can be attained is defined as a rational flow of activity from research through

exploratory and advanced development. The objective is to demonstrate that the desired technology is sufficiently well in hand that the subsequent required effort will be primarily engineering. Interfaces with other subdisciplines and major disciplines are identified. The dependence on, and impact of, developments in other technology areas are addressed, as well as the timing requirements on such interdisciplinary impacts.

The above Plan preparation approach is portrayed in figure 3.

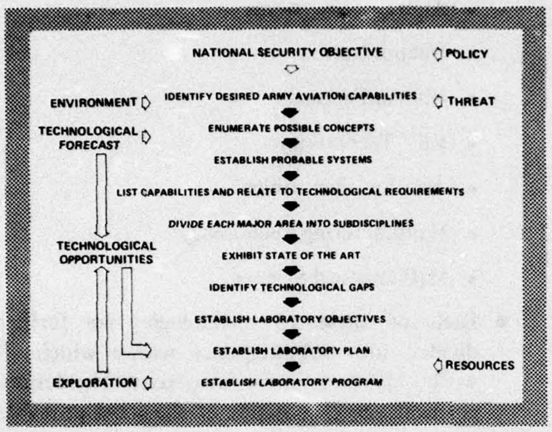

Figure 3. Preparation sequence for Army aviation plan

Technological program direction is included to provide program management an insight as to the application of the tools provided in the Plan towards program planning. As stated previously and repeated for emphasis, the Plan establishes the basis for programming but is not in itself a program. All of the ingredients necessary for program planning are introduced for the AMRDL technology areas and major technical trusts evolved via the OPR process.

Synopses of AMRDL's 6.1, 6.2, and 6.3 current projects and some AVSCOM projects have been included in the applicable technological sections with FY77 Command Schedule funding shown for the various projects.

Progress in improving the performance of Army aircraft is paced by the technological advancements in the 13 basic and supporting technologies discussed above. Advances in state-of-the-art technology can only be made if the technology is validated by component or system demonstration in actual or simulated flight conditions. The Advanced Technology Demonstrator section of the Plan discusses the technological advances which will be validated on demonstrator aircraft or by simulation.

The documentation format is described in figure 4. The development of air mobile systems is first described in the system sections of the Plan. Technological discussions and program directions with objectives, in response to systems needs and past trends are then described in the technologies sections. Finally, resource requirements to achieve these objectives are discussed.

The Plan is published in an unclassified edition and is supplemented by a classified annex which contains CONFIDENTIAL material on some of the systems and topics as listed in table A.

ARMY AVIATION SYSTEMS REQUIREMENTS

The use of air vehicles by ground forces has added another dimension to the battlefield by enhancing the ability to conduct land combat functions. The traditional functions of land combat include mobility, intelligence, firepower, combat service support, and command, control, and communication. Use of Army aviation by ground forces is based on certain fundamental concepts of employment that include the following:

- Aircraft are integrated into ground units. Under this concept, aircraft are considered equipment used as an integral part of land combat. The use of airspace is transitory and directly related to the performance of land battle.
- Army policy is to assign aircraft to the lowest user level that can demonstrate a fulltime use of the aircraft and that can accommodate and support it.
- The aircraft should perform its functions by placing the least possible burden on the ground element for support.

As a consequence of the above concepts, and as a result of Army experience with aviation in combat, certain additional criteria have been developed that bear directly on required aircraft characteristics.

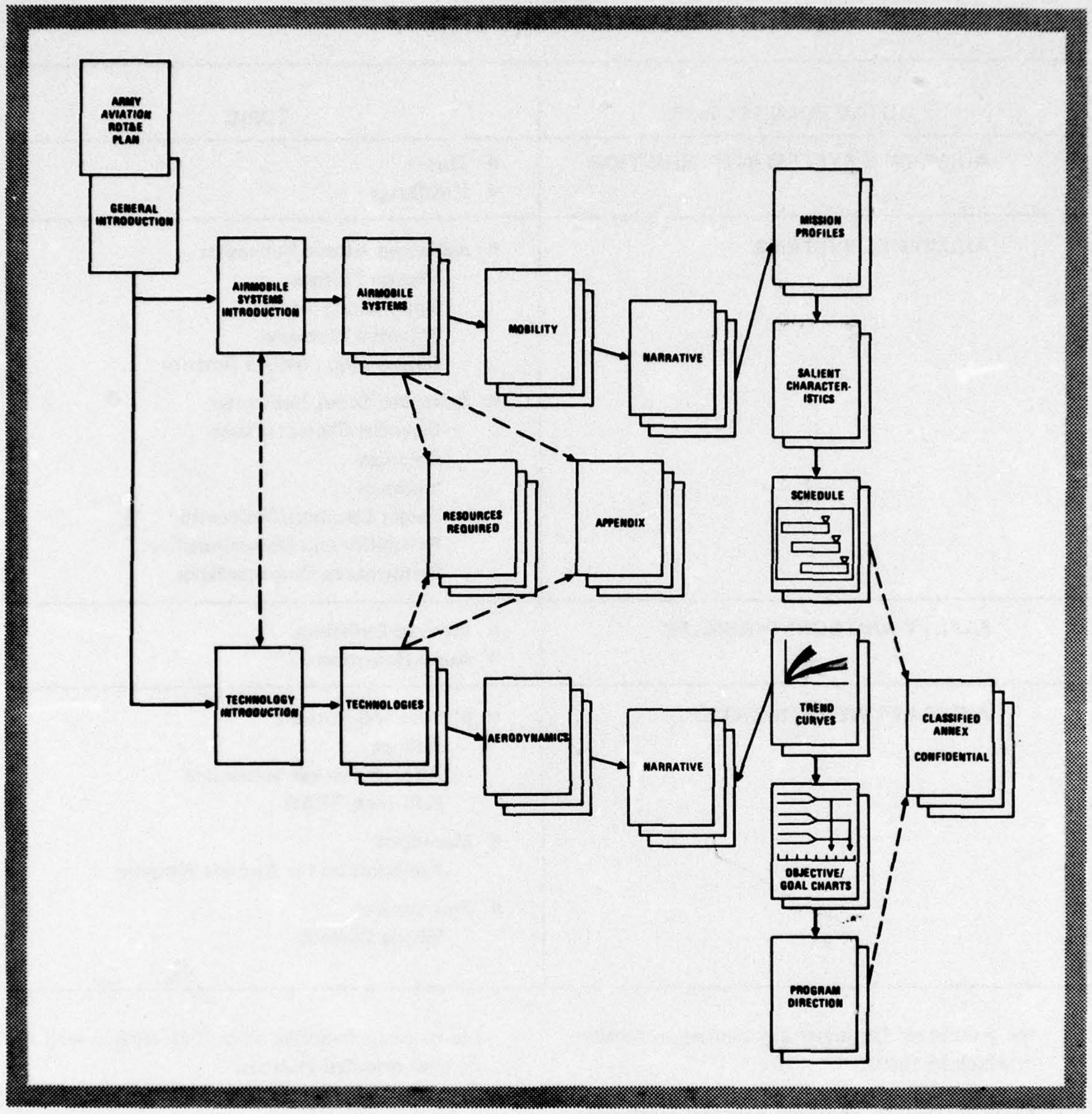

Figure 4. Document format.

These characteristics for vertical takeoff and landing (VTOL) aircraft include the following:

- The ability to hover out of ground effect at 4,000 ft pressure altitude, 95° F at basic mission weight with a 500-ft-per-min vertical rate of climb and 95 percent normal rated power, thus permitting aircraft to be based close to the tactical user without prepared airfields.
- Adequate speed to ensure timely response, productivity (ton miles per hour, missions per day, etc.), and survivability. Generally, high speeds are desirable but can be costly in terms of power required, design complexity, dynamic component life, and direct costs such as forward area refueling support, airframe costs, maintenance costs, and size/weight of aircraft. As such, high speeds must find justification in terms of reduced aircraft losses and increased cost effectiveness of overall mission performance.
- All-weather, full-instrument flight capability, providing effective organic aviation support to

TABLE A
CLASSIFIED TOPIC LISTING

RDT&E PLAN SECTION	TOPIC
AIRMOBILE SYSTEM INTRODUCTION	• Threat • IOC Dates
AIRMOBILE SYSTEMS	• Advanced Attack Helicopter Mission Profiles Opportunity Areas Potential Problems Current and Planned Activity • Advanced Scout Helicopter Essential Characteristics Avionics Visionics Target Location/Designation Reliability and Maintainability Performance Characteristics
SAFETY AND SURVIVABILITY	• Infrared Emissions • Aural Detection
AIRCRAFT WEAPONIZATION	• Missiles and Rockets Hellfire Aircraft Rocket Subsystem 2.71-Inch FFAR • Munitions Ammunition for Aircraft Weapons • Fire Control Missile Control

the ground soldier under any climatic condition in which he fights.

- Crashworthiness, requiring prevention of post-crash fires, energy-absorbing structures for crash impact, and crew restraining devices to enhance survival.
- Survivability, requiring the ability to survive enemy fire without high penalties in aircraft weight, size, or cost.
- Terrain flying, requiring the ability for flight in such a manner as to utilize the terrain, vegetation, and man-made objects to enhance survivability by degrading the enemy's ability to visually, optically, or electronically detect or locate the aircraft. This requirement is applicable to cargo handling aircraft systems as well as combat oriented systems.

The three operational concepts require that Army aircraft meet the user's functional needs, possess characteristics that permit the user to have ready access to the aircraft, and not place great demands on the user for support. Considerations such as these are the genesis of Army requirements documents for such characteristics as VTOL, simplicity, reliability, and maintainability. For the aircraft characteristics, the requirement to hover originates directly from the need to base aircraft with the user, be immediately responsive in terms of time, and negate demands on the user in airfield construction or protection. The aircraft should be capable of existing within the normal perimeter of tactical ground units. This

concept of livability translates directly into characteristic requirements for low-disc-loadings and low noise levels. Related characteristics are those of agility and maneuverability in the air and on the ground.

The concept of minimal special support generates characteristics related to ground support maintainability, simplicity, and reliability. The effect of these characteristics on capability must be carefully assessed through tradeoff studies. Advances in the state-of-the-art must provide the additional benefits without the penalties that would reduce the effectiveness of Army aviation.

THREAT

The Army in the future will have a continuing need for new and improved materiel systems to enable it to fulfill its role in the national defense. In order for a proposed weapon system to prove a worthwhile addition to the Army inventory, careful consideration of potential adversary capabilities and intentions must be a part of the development process. Simply stated, the Army has to be aware of threat and take measures to reduce or negate it.

For R&D considerations, the capability differences between our systems and those of a possible enemy must be known. In addition, their method of material operation and mode of deployment must be established to the maximum extent possible. Furthermore, these factors must be considered up to 10–20 years in the future. The threat is "what you shoot at and what shoots at you," and any countermeasures which would reduce the effectiveness of our systems. The threat is a key facet of the developmental process, is applicable throughout the life cycle of Army materiel, and is a key driving element in the development of the Plan.

MAJOR THRUSTS

A study of the deficiencies and shortcomings of current Army aircraft reveals many areas of commonality, such as lack of survivability, high life cycle costs, inadequate performance, etc. A similar analysis of potential problem areas for future systems results in similar common problem areas. Solution of all the problem areas would require greater resources than may be available to the DARCOM. Emphasis has been placed on the DA specified science and technology objectives, with the greatest effort being applied in the areas where technology breakthroughs or advances would significantly improve the combat capability of current or developing aircraft systems.

As a result of the emphasis placed upon the current major thrusts, R&D efforts may resolve or reduce the significance of a particular problem. At that time a realinement of the thrusts should take place to recognize new areas of highest potential payoff. The identification of problems presented in the Plan provides a method for identifying these areas.

ANALYSIS OF AIRCRAFT CONCEPTS

The Airmobile Systems section of the Plan defines specific performance requirements for the application of airmobile systems to the land combat functions of mobility, intelligence, firepower, combat service support, and command, control and communications as shown in figure 5 and discussed briefly below. Included in the figure matrix are operational systems, developing systems, and R&D planning concepts. All three categories are discussed in detail in the Plan.

The Plan defines specific performance requirements for the developing systems. For the R&D planning concepts, more general performance requirements are described. In either case, it is possible to identify the most promising aircraft concepts to best satisfy these requirements and the research efforts needed to develop the technology base to support these concepts. In some instances, a specific airmobile system description includes technological deficiencies (voids) that must be resolved by research to permit the development of a viable system. This "demand pull" effort is discussed in General Introduction section of the Plan.

Mobility. The demand for greater mobility has continuously increased throughout the history of warfare. The airmobile capability that began in the Korean conflict and proved so valuable during the recent experience in Vietnam will be equally, if not more, valuable in the future. The ability to quickly redeploy light mechanized units and mobile air defense artillery by air and to transport assault

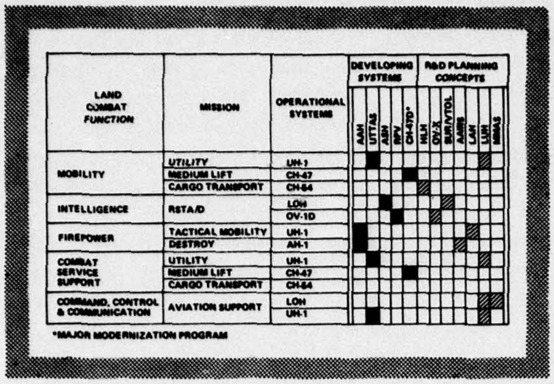

Figure 5. Land combat function mission systems.

troops, weapons, and equipment around the battlefield, over obstacles, and bypass enemy strong points should prove particularly valuable in any future conflict.

For squad-size units and small weapons, the utility mission of the mobility function is currently being performed by the UH-1, which will be replaced by the Utility Tactical Transport Aircraft System (UTTAS). The UTTAS will lift a basic tactical infantry squad or its transport equivalent of externally or internally loaded bulk cargo. For units of larger size or heavier weapons, the CH-47 provides the necessary mobility, medium lift. Because of its vulnerability, the CH-47 is rarely used in the combat assault role but provides maneuverability to the fire support elements and other supporting units. The CH-47 Modernized Medium Lift Helicopter (MLH) (to be designated as the CH-47D) is projected to replace the CH-47 for payloads in the 7- to 10-ton range. For large outsized loads requiring external slinging, the CH-54 helicopter is currently used. For future R&D system planning, the Heavy Lift Helicopter (HLH) System is projected for lift capability of 20 tons up to 50 tons. A quick reaction/high productivity type aircraft, such as the tilt rotor configuration, is needed for a future utility system. In addition, a Light Utility Helicopter (LUH) with performance and physical characteristics compatible with the Advanced Scout Helicopter (ASH) is also needed to assume many of the missions associated with mobility, combat service support, and command, control, and communications.

Intelligence. Army aviation performs this function in the role of the collecting and gathering of intelligence for the ground commander and for the acquisition and designation of targets for engagement by armed helicopters and other firepower means. The primary mission for this combat function is reconnaissance, surveillance, target acquisition and designation (RSTA/D). In addition, electronic warfare, decoy, and communication relay can be classified under this function although there is a definite overlap between intelligence and command, control and communications for some of the mission requirements.

The key requirements for this function are good visibility, aircraft agility, simplicity, survivability, and ability to fly under conditions of reduced visibility and darkness. For the longer range intelligence gathering mission, the requirements are survivability, precise navigation, dash speed, and ability to carry sophisticated sensors providing real time readout of targets to ground stations.

Currently, this function is being performed by the OH-58 and OH-6 Light Observation Helicopters (LOH) and for the stand-off mission, by the OV-1D Short Takeoff and Landing (STOL) airplane. The ASH is currently in the planning stage to replace the LOH for this function and a draft LOA is being staffed for a replacement for the OV-1D. The OV-X platform will only provide standoff mission capability operating from a fixed site. For penetration missions, VTOL capability will become a prime requirement. A candidate configuration for a manned surveillance VTOL aircraft (SUR/VTOL) is the tilt-rotor concept. Remotely Piloted Vehicles (RPV) are being developed to perform this function for operation in the high threat environment.

Firepower. The firepower function includes two mission definitions. One is to destroy or disrupt enemy armor and mechanized forces by aerial firepower and the other is to provide tactical mobility and support air assault or airmobile operations throughout the battle area.

Currently, Army aviation provides firepower via the AH-1G Cobra armed helicopter. Greater capability, particularly in the antitank role, will be provided by the AH-1Q (Cobra-TOW) as an interim system. Key factors are the discriminating nature of direct aerial fire support to be close in, highly responsive, and available in all-weather and at night. The Advanced Attack Helicopter (AAH) provides increased firepower, flexibility, all-weather operation, and increased survivability aspects over the current systems. The UH-1 has in the past been used to provide the Army with tactical mobility capability.

R&D efforts are necessary to continue technological improvements in the systems key performance factors. Advancements in weapons, sensors, propulsion, aerodynamics, and structures as well as tactics may well lend to the AAH being behind the state-of-the-art in the early 1990s. One postulated R&D planning concept for the replacement of the AAH is the Advanced Aerial Weapons System (AAWS).

To provide a complete combined arms team, R&D planning efforts should include a Light Attack Helicopter (LAH) to supplement the AAH by providing economical armed reconnaissance and fire support to small combat units.

Combat Service Support. This function involves the traditional combat service support function of providing an airline of communication capable of delivering supplies from a rear storage area to the immediate vicinity of the user. The "retail" delivery of high priority cargo to the company and platoon areas is accomplished by utility helicopters, while cargo helicopters (CH-47, CH-54) perform the "wholesale" bulk delivery of high priority cargo. Relatively short distances are involved, but within inhospitable environment and terrain. Fixed bases are generally not available; hence, VTOL capability is a requirement. In this respect, the prime mission of the HLH will be the delivery of containerized cargo from offshore positions, across the beach, and to forward supply areas. This capability is particularly advantageous when port and transport facilities are either inadequate or not available. In addition, the recovery of damaged equipment or captured enemy material can be accomplished by the larger cargo helicopters. For transport of supplies to the forward area in a high threat environment, a system capable of carrying external loads in nap-of-the-earth flight profiles and in day-night all-weather condition is required. In addition, the cargo handling subsystem should be as automated as possible to eliminate ground handling crews.

Command, Control, and Communications. The function of command, control and communication is made more challenging by the far-ranging operations envisioned for an expanded battlefield. Rapid movements and immediate response are required to supervise a widely dispersed operation. Currently performed by LOH and UH-1 aircraft, this capability for future operations should be expanded down to the company level. The UTTAS and improved version of the LUH are projected to perform this role for the battalion and higher commanders while the company level operation requires a simple, small NOE Mini-Manned Aircraft System (MMAS) capable of hovering and transporting specialized troops.

The developing and R&D planning concept airmobile systems with specific mission capabilities and key performance factors are shown in table B.

TECHNOLOGICAL REQUIREMENTS

The missions, concepts, and assigned IOC dates represent the current projection of the Army's aviation needs that have been analyzed to identify technology gaps. Following estimation of the performance requirements and operational needs, it was then possible to predict the technological developments that must be pursued in support of the specific systems and concepts that were identified. The mechanism for identifying, justifying, and establishing research projects and tests to provide development data for integration into the system design of future aircraft is the continual conduct of conceptual and design studies of the options for the various mission requirements. Required advances in the disciplines and supporting technologies are identified by such studies. (The studies also form the basis of a development plan.) However, the chief characteristics of air vehicle technology are its interdisciplinary nature and very broad spectrum. It is important to recognize the interfaces of the many components, equipments, disciplines, and sciences that make up the totality of the airmobile systems design problem. The many faceted interrelationships of the essential elements in the aircraft design process aligned with the life cycle phases and program categories are portrayed in chart I.

If the synthesis of the aircraft system performance capabilities is a complex problem, the analysis of specified performance requirements to determine the impact on the subsystems, disciplines, and technologies is even more so. Development of the final coordinated Plan relied heavily on experience with the synthesis problem and on the projected technological trends.

Development schedules were predicted that covered, for each aircraft option, time from start of the project to projected IOC date. These schedules were used to estimate development lag time required, thus

TABLE B
ARMY AIRMOBILE SYSTEMS MISSION AND KEY PERFORMANCE FACTORS

SYSTEM	MISSION	KEY PERFORMANCE FACTOR
AAH	• Provide Aerial Fire Support • Tactical Mobility and Support	• Acquire/Destroy Targets • Survivability
UTTAS	• Squad Carrier • Combat Service Support	• Low Life Cycle Cost • R&M Improvement
ASH	• RSTA/D • Direct Aerial Fire Support	• All Weather Day/Night Capability • Agility
RPV	• Unmanned RSTA/D	• Low Acquisition Cost
CH-47D	• Medium Lift Transport	• Payload • Reliability
HLH	• Transport of Cargo • Retrieval of Equipment	• Capacity • Precision Hover
OV-X	• Intelligence • Electronic Warfare	• Endurance • Payload
SUR/VTOL	• Intelligence • Electronic Warfare	• Forward Area Operation • Penetration Capability
AAWS	• Area and Point Target Suppression • Extended Area Reconnaissance	• Acquire/Destroy Targets • Survivability
LAH	• Armed Reconnaissance • Area and Point Target Suppression	• Survivability • Compatible with ASH
LUH	• Troop Lift • Utility Transport	• All Weather Capability • Compatible with ASH
MMAS	• Observation • Visual Reconnaissance • Command and Control	• Forward Area Operation • Operation/Maintenance Simplicity

establishing the time required for technological objectives to be achieved to meet the IOC date. The life cycle of a new aircraft system and the time and method by which technological advancements are incorporated into it vary greatly, depending upon the complexity of the system, availability of new advancements and their cost effectiveness. In general, a new aircraft experiences a life cycle that includes most of the elements shown in chart I. It was assumed that contract definition (beginning engineering development) occurred, on the average, about 8 years prior to IOC and initiation of exploratory development was required about 7 years prior to contract definition. The objective in all cases was to have completely developed and demonstrated technology on the shelf, ready for engineering design of the system, in a timely manner prior to engineering development.

The impact matrix presented in chart II represents the relationship between key operational requirements for each of the systems considered, and the technological objectives for 12 disciplines and technologies. (Mathematical Science is not listed as it does not have a first-order effect on the areas listed.)

The major portion of the planned research effort is directed toward rotary-wing aircraft, which are expected to be the prime source of Army air power in the future. However, other subsonic aircraft, capable of vertical or short takeoff and landing, have not been precluded.

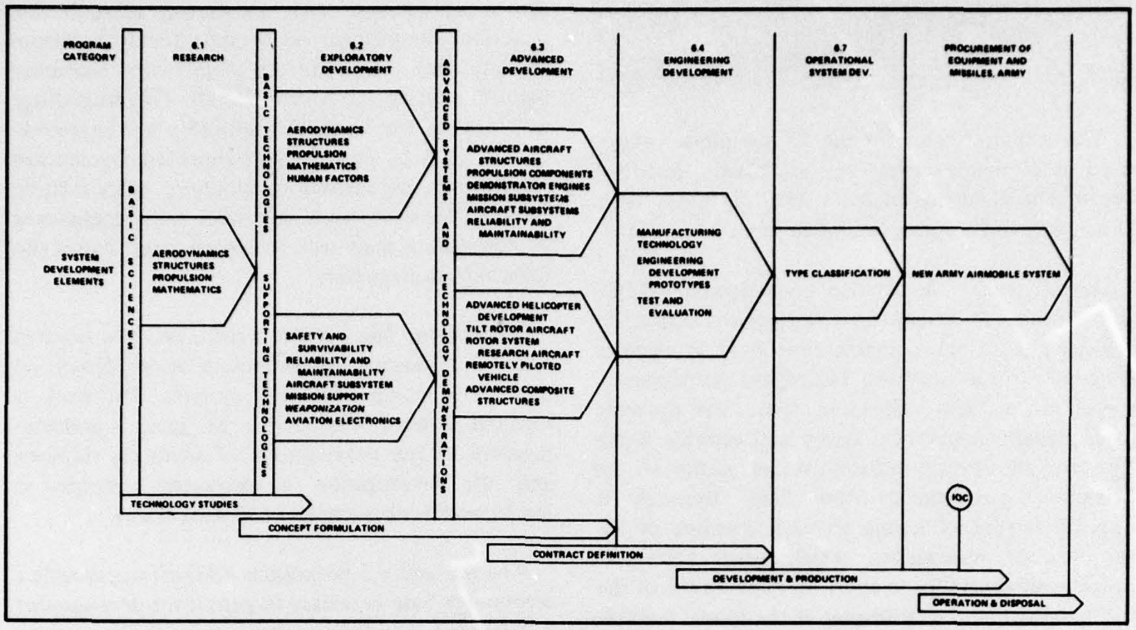

Chart I. Relationships of Technologies for New Airmobile Systems

ANALYSIS OF R&D TASKS

The 13 disciplines categorized as airmobile technology with supporting disciplines of Advanced Technology Demonstration, Aircraft System Synthesis, Fundamental Science, and Resources Required comprise Army aviation R&D aeronautical technology. All work objectives are categorized within the key subdisciplines and each is time phased, quantified wherever possible, and presented graphically. Priority of effort is addressed and interactions of work objectives in each subdiscipline are portrayed graphically. Interdependencies with developments in other disciplines and technologies are discussed. Efforts in one subdiscipline cannot be redirected without being fully aware of the consequences in the other disciplines.

Advances in the basic aeronautical sciences and supporting technologies make up the foundations on which are laid the interdisciplinary developments and finally, the design for new systems. The combination of all these accomplishments in a pyramid-like structure is required to support demonstration of technology to attain the desired performance for each system/component. The example of figure 6 is for a tilt-rotor concept as applied to the intelligence mission function and was derived from information presented in the Plan. This presentation helps to display the pacing technology areas and provides another aspect of the interdependencies of accomplishments in the sequential, mission-oriented sense.

It is apparent from an analysis of the Plan that VTOL aircraft technology is expected to experience significant advances over the 20-year timeframe that is addressed. Improved rotor performance, reduced structural weight ratios, and reduced specific fuel consumption are certain to be realized. Solid-state, integrated microelectronic circuitry will enable the provision of onboard miniature computers and other devices that will greatly enhance navigation, control, and fire-control capabilities over current systems, making possible all-weather and night operations, even in the nap-of-the-earth. Better reliability and reduced maintenance requirements are sure to evolve, as will self-contained test capability. A dominant improvement sought is development of aircraft that can take (and avoid) punishment meted by the hostile environment typical of Army aviation.

The advances in aircraft technology can only become an integral part of the R&D cycle when the advancement has been validated by component or system demonstration in actual or simulated flight conditions. The near-term technological advances undergoing validation are discussed in considerable detail in the Plan.

AMRDL R&D PROGRAM DIRECTION

The technical areas for the 13 disciplines categorized as airmobile technology are briefly described below. The discussion includes AMRDL R&D efforts in 6.1, 6.2, and 6.3 program categories.

Aerodynamics. A detailed understanding of the aerodynamics of helicopters is particularly difficult to achieve due to the complex flow field in which a helicopter rotor operates. Helicopter performance, aeroelastic stability, vibration, static and dynamic loads, handling qualities, agility and acoustic signature are all directly related to the nature of the helicopter aerodynamic flow field. Research is directed toward obtaining an understanding of the aerodynamic mechanisms which affect helicopter operational capability to allow for exploitation of the full potential of the helicopter at the lowest possible cost. As a result, the aerodynamics research program covers a broad range of efforts.

The 6.2 and 6.3 aerodynamics technology program makes use of results from the 6.1 research in aerodynamics to develop a broad technology base for advanced helicopter development. The understanding of basic aerodynamic mechanisms from the research is interfaced with hardware concepts to provide tools and components for use in development of advanced helicopter designs.

Structures. This technical area consists of the basic research necessary to provide the fundamental structures and materials application technology required for subsequent demonstration of improvements in rotary wing safety, survivability, and mission effectiveness through a viable aviation structures program. The efforts under this project are directed toward the development of analytical techniques for complex structures to include metal, composites, and metal reinforced with composites, as well as to develop the fatigue characteristics of these structures and demonstrate the utilization of these materials on rotary wing aircraft. The fracture characteristics of materials will also be determined in order to develop adequate fracture control procedures and techniques.

The structures 6.2 and 6.3 R&D efforts are directed toward the development and demonstration of the techniques and design criteria necessary to provide adequate structural design loads criteria, aeroelastic stability, static and fatigue strength, and structural integrity for Army aircraft and to improve the capability to analyze and predict these characteristics in existing and future aircraft. This technology will increase the aircraft's availability and survivability as well as provide for improved operational effectiveness and mission capability of Army aviation systems. These research objectives are accomplished by conducting analytical, structural, wind tunnel and flight test investigations.

Propulsion. This project consists of basic research aimed at advancing the technology of propulsion and drive train components and systems. The work is directed toward the solving of special problems involved in the development of small gas turbines, and the investigation of advanced concepts in mechanical devices employed in drive trains.

The 6.2 and 6.3 propulsion R&D efforts provide a technology base necessary to permit the development of advanced propulsion systems and drive trains with increased effectiveness over existing systems.

Reliability and Maintainability. R&M technology addresses the development of the engineering expertise and methodology required to assure that specified performance and operational levels can be sustained and maintained. Improved military operational capability is being advanced through the R&M technological development of diagnostic/condition monitoring capability, advanced R&M component design concepts, total system R&M analysis capability, and improved testing methodology for R&M characteristics of vehicle subsystems. These efforts are directed towards reducing life cycle costs and maintenance burden focusing on the reliability and maintainability aspects of design. Research in the R&M area is conducted in both the 6.2 and 6.3 program categories.

Safety and Survivability. The purpose of this project is to develop advanced technology and design criteria to enhance Army aircraft effectiveness in terms of increased survivability and safety of flight. Survivability includes the reduction of detection by IR, radar, optical and aural sensors, increased ballistic tolerance of threat projectiles, and development of means to counter future weapons such as lasers. Safety of flight encompasses operational safety of aircraft and crew through increased crashworthiness of structure and crew seats, prevention of post crash fire, elimination of inflight hazards, and provision for

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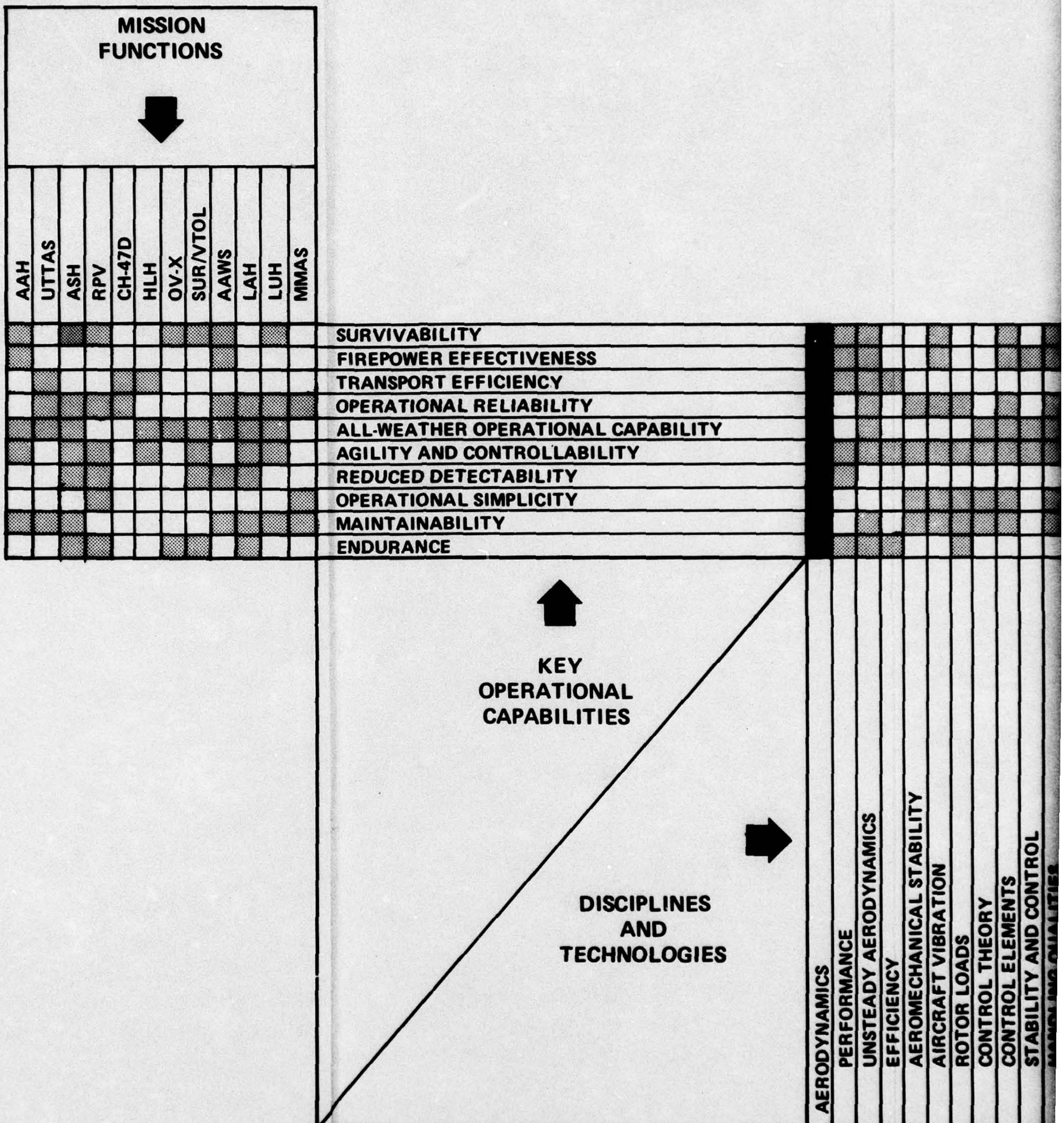
MISSION FUNCTIONS
AAH
UTTAS
ASH
RPV
CH-47D
HLH
OV-X
SUR/VTOL
AAWS
LAH
LUH
MMAS
SURVIVABILITY
FIREPOWER EFFECTIVENESS
TRANSPORT EFFICIENCY
OPERATIONAL RELIABILITY
ALL-WEATHER OPERATIONAL CAPABILITY
AGILITY AND CONTROLLABILITY
REDUCED DETECTABILITY
OPERATIONAL SIMPLICITY
MAINTAINABILITY
ENDURANCE
KEY OPERATIONAL CAPABILITIES
DISCIPLINES AND TECHNOLOGIES
AERODYNAMICS
PERFORMANCE
UNSTEADY AERODYNAMICS
EFFICIENCY
AEROMECHANICAL STABILITY
AIRCRAFT VIBRATION
ROTOR LOADS
CONTROL THEORY
CONTROL ELEMENTS
STABILITY AND CONTROL

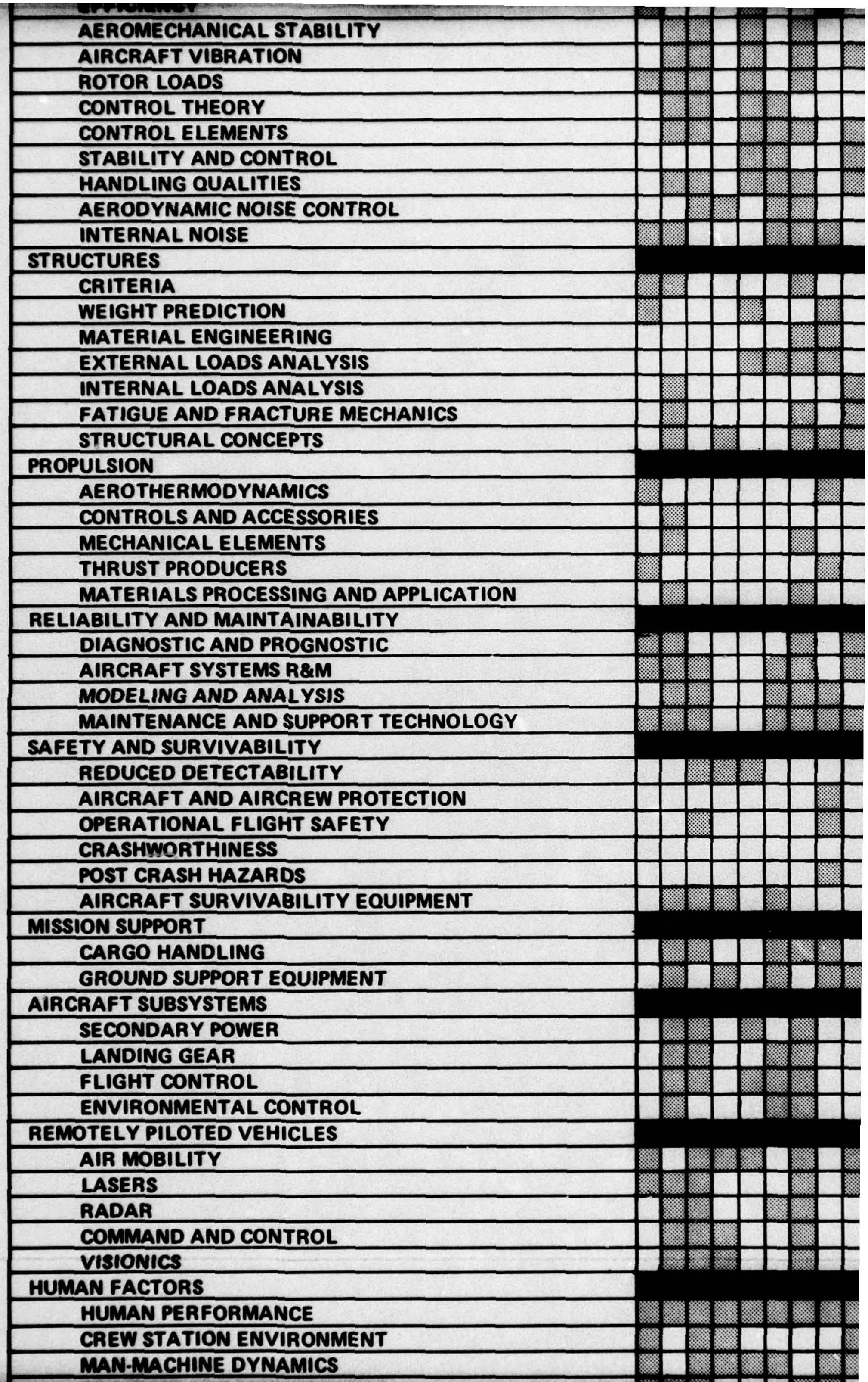

Chart II. Technology Impact Matrix

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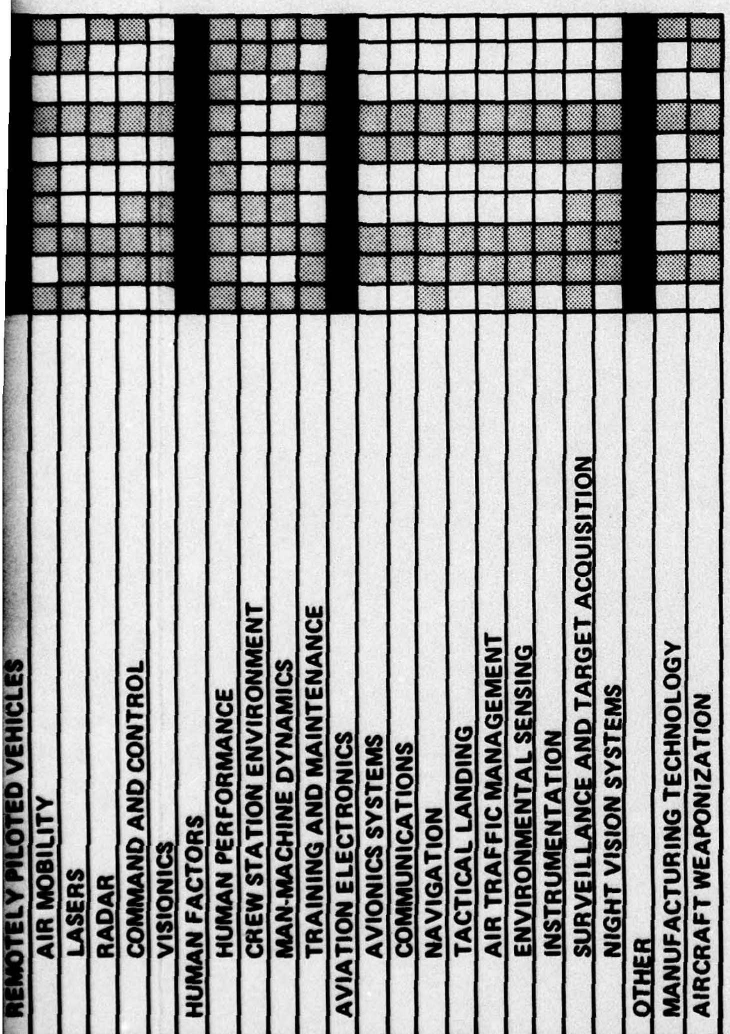

REMOTELY PILOTED VEHICLES
AIR MOBILITY
LASERS
RADAR
COMMAND AND CONTROL
VISIONICS
HUMAN FACTORS
HUMAN PERFORMANCE
CREW STATION ENVIRONMENT
MAN-MACHINE DYNAMICS
TRAINING AND MAINTENANCE
AVIATION ELECTRONICS
AVIONICS SYSTEMS
COMMUNICATIONS
NAVIGATION
TACTICAL LANDING
AIR TRAFFIC MANAGEMENT
ENVIRONMENTAL SENSING
INSTRUMENTATION
SURVEILLANCE AND TARGET ACQUISITION
NIGHT VISION SYSTEMS
OTHER
MANUFACTURING TECHNOLOGY
AIRCRAFT WEAPONIZATION

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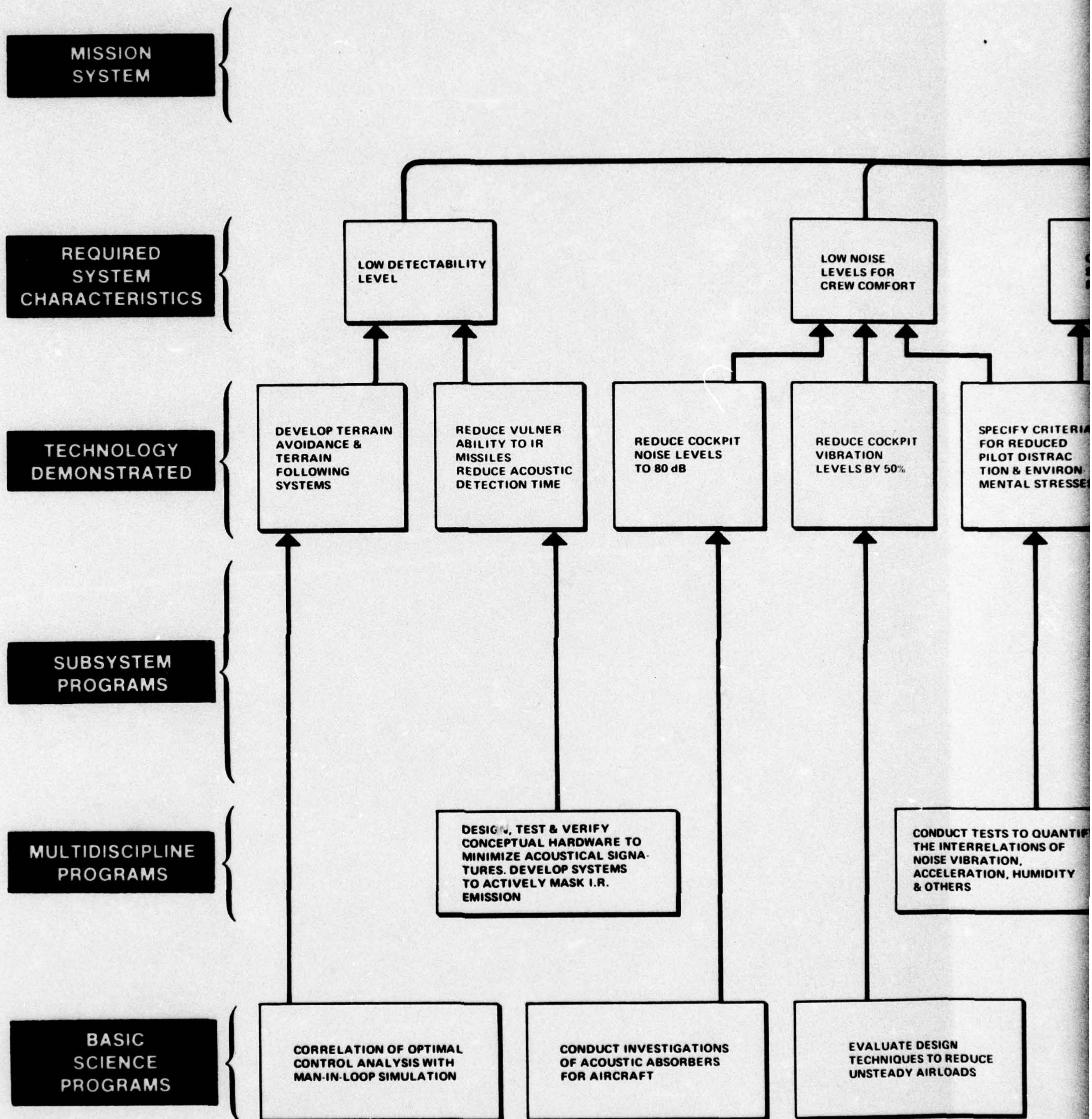


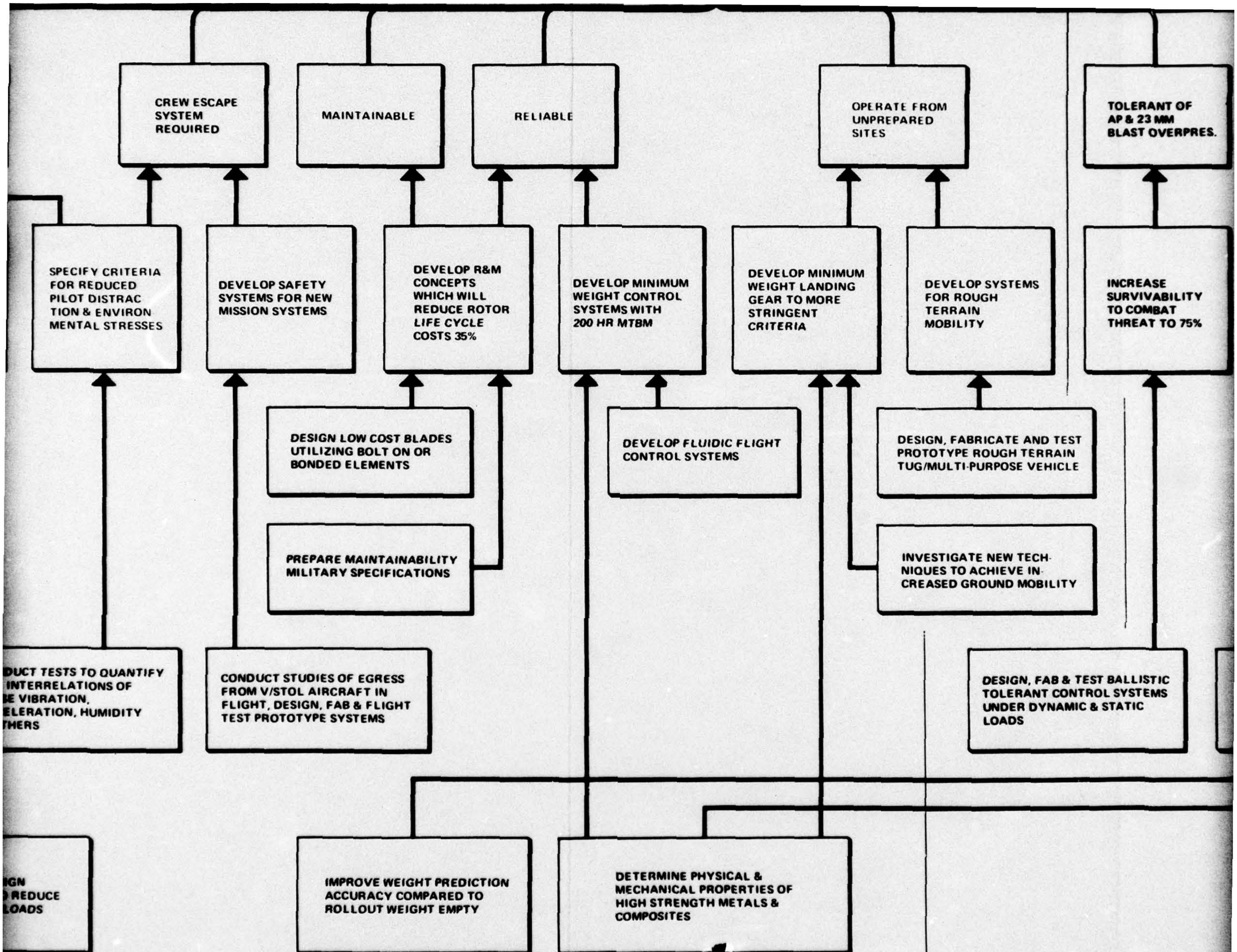
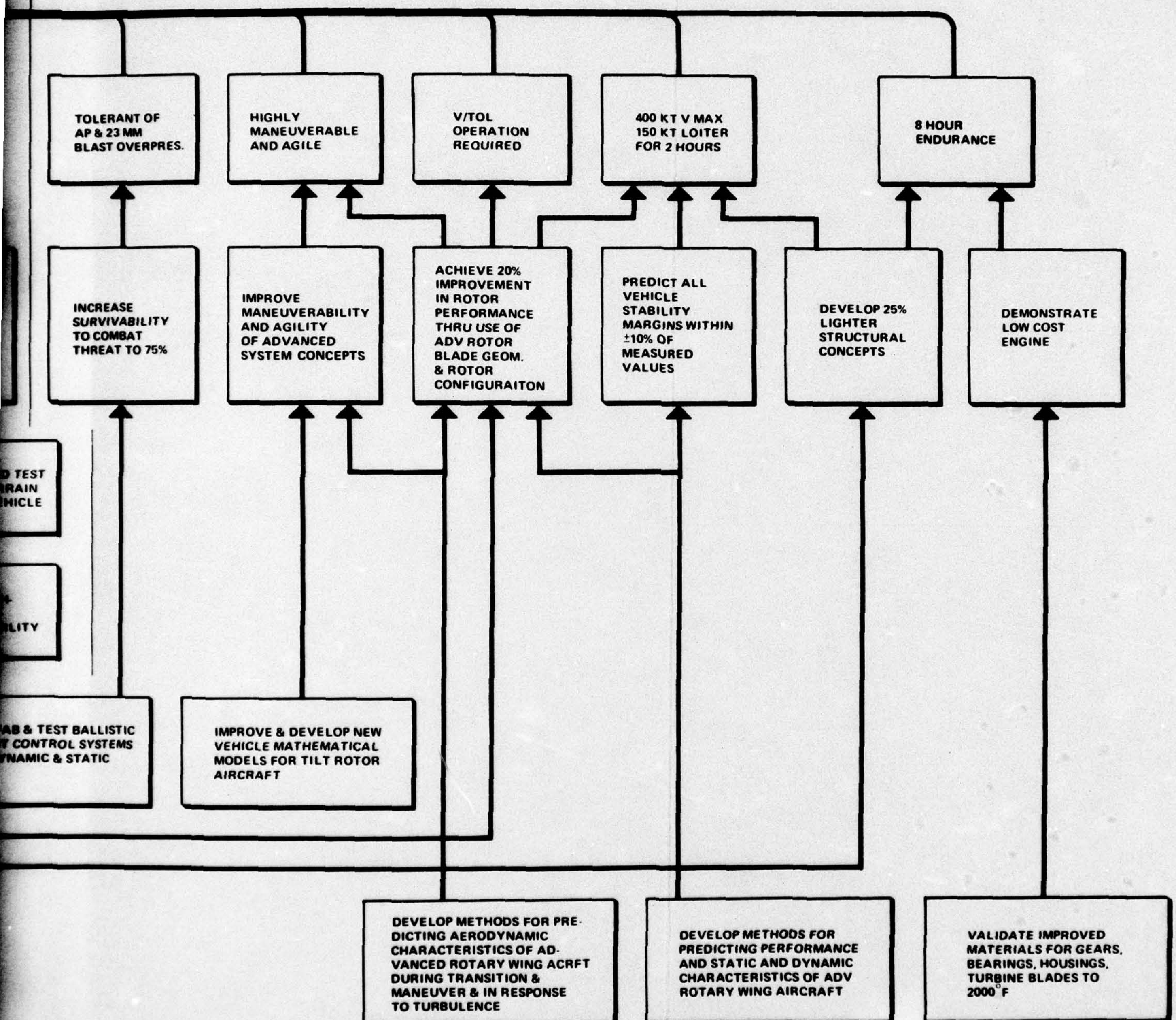


Figure 6. Pyramidal structure of accomplishments for SUR/VTOL and tilt rotor.


TOLERANT OF AP & 23 MM BLAST OVERPRES.
HIGHLY MANEUVERABLE AND AGILE
V/TOL OPERATION REQUIRED
400 KT V MAX 150 KT LOITER FOR 2 HOURS
8 HOUR ENDURANCE
INCREASE SURVIVABILITY TO COMBAT THREAT TO 75%
IMPROVE MANEUVERABILITY AND AGILITY OF ADVANCED SYSTEM CONCEPTS
ACHIEVE 20% IMPROVEMENT IN ROTOR PERFORMANCE THRU USE OF ADV ROTOR BLADE GEOM. & ROTOR CONFIGURAITON
PREDICT ALL VEHICLE STABILITY MARGINS WITHIN ±10% OF MEASURED VALUES
DEVELOP 25% LIGHTER STRUCTURAL CONCEPTS
DEMONSTRATE LOW COST ENGINE
D TEST
RAIN
HICLE
LITY
AB & TEST BALLISTIC
T CONTROL SYSTEMS
YNAMIC & STATIC
IMPROVE & DEVELOP NEW VEHICLE MATHEMATICAL MODELS FOR TILT ROTOR AIRCRAFT
DEVELOP METHODS FOR PREDICTING AERODYNAMIC CHARACTERISTICS OF ADVANCED ROTARY WING ACRFT DURING TRANSITION & MANEUVER & IN RESPONSE TO TURBULENCE
DEVELOP METHODS FOR PREDICTING PERFORMANCE AND STATIC AND DYNAMIC CHARACTERISTICS OF ADV ROTARY WING AIRCRAFT
VALIDATE IMPROVED MATERIALS FOR GEARS, BEARINGS, HOUSINGS, TURBINE BLADES TO 2000°F

emergency egress. The results of these efforts are applicable to retrofit of current aircraft and development of criteria for design of developmental and future aircraft systems.

Mission Support. The purpose of this project is the development of mission support equipment that will enhance the effectiveness of military operational capabilities of Army aircraft. Particular emphasis has been placed on transport of cargo in the high threat environment. General logistics as well as ship-to-shore logistic support is included. Principal technology areas are cargo handling and aircraft ground support equipment with research being conducted in both the 6.2 and 6.3 program categories.

Aircraft Subsystems. Aircraft subsystems applies to those subsystems of the aircraft that provide the basic power to operate all aircraft systems except for main lift and thrust (primary power) systems. Excluded from this definition for this R&D effort are Electronics, Cargo Handling, and Weaponization. The purpose of the project is to advance the state-of-the-art for Army aircraft subsystems such that significant improvements in operational effectiveness and/or reduction in life cycle costs can be achieved. Particular emphasis has been placed on the development of advanced concept aircraft ice protection systems and electrical, hydraulic and pneumatic system improvements. Most of the subsystem R&D efforts are 6.2 category projects except efforts in the environmental area (aircraft ice protection systems) are also conducted in the 6.3 category.

Weaponization. Aircraft weaponization technological development efforts are directed towards research and development to strengthen the technology base of aircraft weaponry. Aircraft weaponization engineering development efforts are aimed to provide the Army inventory with advanced aircraft weapons and improved munitions. The work is conducted primarily by the U.S. Army Armament Command, the U.S. Army Missile Command, the Army Ballistic Research Laboratories, the Project Manager of Aerial Rockets, and the Army Test and Evaluation Command. Additionally, aircraft-weapon subsystem interface capability and advanced development weapon system programs are conducted by the U.S. Army Aviation Systems Command through the Directorate for Research, Development and Engineering and the Air Mobility Research and Development Laboratory.

Human Factors. The aviation human engineering technical effort is a comprehensive program of systematic behavioral research leading to new methods of design and test of air mobility systems. It will also provide better design criteria and tradeoff data for use in system development. The overall goal is to achieve better system performance by means of improved man-machine integration. Efforts are addressed to technology void areas offering the most significant payoffs and are structured to complement the research and development of other units working on related problems. Areas of concentration include methods to assess operator performance and workload, computer modeling of aircrew tasks, requirements and research strategies for employment of flight simulation to aid system development, and improved crewstation environment criteria. All these efforts focus on unique or critical needs for meeting mission effectiveness goals in operations requiring NOE flight and staying power.

RPV Technology. R&D in this technical area encompass 6.2 and 6.3 efforts and will develop and evaluate new technologies in those factors which currently limit the operational potential of RPV's for Army missions. Emphasis will be given to the development of command and control equipment, lasers, radars, visionics, and air mobility capabilities. Day, night, and all weather capabilities will be developed for mini-RPV's for several Army missions. These capabilities do not now exist within the services. Specifically, developments will be pursued in propulsion, launch and recovery, survivability, and manufacturing technology for low cost, mass produced vehicles. Visionics developments include cost/weight reductions on day TV, thermal imagers, and low light level TV. Radar developments will emphasize all weather capabilities; laser programs will develop lighter, more powerful, and higher duty cycle equipments for mini-RPV's. Command and control efforts focus on the development of the Fast Frequency Hop technique as an alternative to the Integrated Communication and Navigation System.

Aviation Electronics. Aviation electronics equipment is that airborne or ground equipment in support of aircraft relies primarily on electronic implementation. The US Army Electronics Command has been given the overall responsibility for avionics research and development within the Army. The US Army Aviation Systems Command, as Weapon Systems Manager, provides guidance and direction through close coordination between the ECOM Avionics Laboratory, the AVSCOM US Army Airmobility Research and Development Laboratory, and

AVSCOM Project Managers. Avionics subsystem/system R&D efforts provide avionics/interface candidate information and equipments for the tradeoff analyses and final system syntheses by the aircraft system designers. Army aircraft in support of ground tactical elements will depend upon improved avionics to provide day/night and adverse weather capabilities for increased survivability and mission capability.

Manufacturing Technology. The primary objective of the AVSCOM Manufacturing Methods and Technology Program is to develop, on a timely basis, manufacturing processes, techniques, and equipment for use in the production of Army Aviation materiel. The overall goal of the MMT program is to assure that the Army is able to produce helicopters with maximum performance and reliability at a reasonable cost.

Several of the FY77 efforts in MMT are directed specifically at the General Electric T700 engine to be used on both the UTTAS and the AAH. These projects will be implemented immediately upon their completion and offer a substantial return-on-investment.

Mathematical Science. Aerodynamics, structures, and decision risk analysis constitute the general domain to which much of the AMRDL mathematics research efforts are devoted. In aerodynamics, studies are primarily directed toward the solution of complex helicopter rotor flow problems through utilization of the ILLIAC IV parallel processor. In structures, emphasis is placed on efficient mathematical techniques for the determination of stability and transient response characteristics of large systems differential equations associated with the dynamics of helicopter rotors and fuselage. Development of quantitative technique for technical risk assessment is the main concern of the risk analysis effort.

ANALYSIS OF [illegible]

The precise quantitative magnitude of technological improvement that can be achieved is governed by other than purely technical considerations. Political policy is a major element but impossible to predict and has been ignored. Of major importance are budgetary and schedule constraints that limit the amount of design optimization and technological advance. Under conditions of limited resources, imposed economics, and prescribed goals, a logical resource allocation methodology is the key to orderly progress. At present, this allocation is made at staff levels in conjunction with AMRDL's OPR (Objectives-Priority-Rational) Project Selection Process.

It is not likely that all the efforts described in the Plan would be pursued or all the goals achieved. Furthermore, the available options and alternatives to perform the given task diminish with time and, consequently, estimates of resource requirements are valid only on a relatively short-term basis.

Funding summaries, based on the FY77 Command Guidance Schedule are provided for the various programs discussed in the Technological Program Direction subsection of the technology disciplines.

LIST OF ABBREVIATIONS AND ACRONYMS

AAH	Advanced Attack Helicopter
AAWS	Advanced Aerial Weapons System
AMC	(U.S.) Army Materiel Command (now DARCOM)
AMRDL	(U.S. Army) Air Mobility Research and Development Laboratory
ASH	Advanced Scout Helicopter
AVSCOM	(U.S. Army) Aviation Systems Command
DA	Department of the Army
DARCOM	(U.S. Army) Materiel Development and Readiness Command
ECOM	(U.S. Army) Electronics Command
FY	Fiscal Year
HLH	Heavy Lift Helicopter
HQ	Headquarters
ILLIAC IV	Fourth Generation Computer with Sixty-Four Slave Processors Working on Master/Slave Concept
IOC	Initial Operational Capability
LOA	Letter of Agreement
LOH	Light Observation Helicopter
LUH	Light Utility Helicopter
MLH	Medium Lift Helicopter
MMAS	Mini-Manned Aircraft System
MMT	Manufacturing, Methods, and Technology
NATO	North Atlantic Treaty Organization
NOE	Nap of the Earth
OPR	Objectives, Priority, and Rationale
PEMA	Procurement of Equipment and Missiles, Army
R&D	Research and Development
RDT&E	Research, Development, Test, and Engineering
R&M	Reliability and Maintainability
RPV	Remotely Piloted Vehicle
RSTA/D	Reconnaissance, Surveillance, Target Acquisition and Designation
STOE-77	Science and Technology Objective Guide, FY77 (CONFIDENTIAL)
STOL	Short Take Off and Landing
SUR/VTOL	Surveillance Vertical Takeoff and Landing Aircraft
TRADOC	(U.S. Army) Training and Doctrine Command
TOW	Tube Launched, Optically Tracked, Wire Guided
TV	Television
UTTAS	Utility Tactical Transport Aircraft System
VTOL	Vertical Take Off and Landing